Claims

1. A system comprising a stripper device for stripping volatile compounds from a liquid medium, said stripper device comprising:

a) a shunt to which aqueous liquid medium comprising volatile compounds can be diverted in the form of a side stream to a fermentor or biogas reactor,

b) pumps, valves and pipes for diverting aqueous liquid medium comprising volatile compounds to the shunt from said fermentor or biogas reactor, and

c) an evaporator device comprising a sample of aqueous liquid to which heat obtained from an external heat source can be added, wherein a reduction of the pressure in said evaporator to a first pressure below a predetermined reference pressure generates cold steam, and

d) pumps, valves and pipes for directing the cold steam generated by the evaporator of step c) through said aqueous liquid medium comprising volatile compounds in the shunt of the stripper device at said pressure below a predetermined reference pressure, thereby stripping off volatile compounds and obtaining a cold, volatile compound-comprising steam, and

e) a first condensing device, and

f) pumps, valves and pipes for diverting said cold volatile compound-comprising steam at said pressure below the predetermined reference pressure to the first condensing device, and condensing in a first condensing step in said first condensing device said cold volatile compound-comprising steam at said pressure below a predetermined reference pressure, thereby obtaining a first condensed aqueous liquid medium comprising said volatile compounds and vapour not condensed by the first condensing device, and,

g) a stripper unit for stripping volatile compounds at said predetermined reference pressure or at a second pressure higher than said predetermined reference pressure,

h) pumps, valves and pipes for diverting said first condensed aqueous liquid medium comprising volatile compounds obtained in step f) to the stripper unit, and stripping off at least part of the volatile compounds from said first condensed aqueous liquid medium comprising volatile compounds by injecting hot aqueous steam at said reference pressure or at the higher second pressure, thereby obtaining a hot volatile compound-comprising steam and aqueous liquid stripped off at least part of said volatile compounds,

i) a second condensing device, and

j) pumps, valves and pipes for diverting said hot volatile compound-comprising steam to a second condensing device, and condensing said hot volatile compound-comprising steam, thereby obtaining a condensate comprising volatile compounds.

2. The system according to claim 1, wherein the stripper device further comprises a further condensing device and pumps, valves and pipes for diverting said vapour not condensed by the first condensing device to the further condensing device for removing at least some of the remaining volatile compounds from said vapour not condensed by the first condensing device, said further condensation involving the step of washing the vapour in a counter current of aqueous liquid, thereby obtaining a combined aqueous liquid fraction comprising the first condensed aqueous liquid medium from the first condensing device and volatile compounds condensed in the further condensing device, and optionally vapour not condensed by the further condensing device.

3. The system according to claim 2 further comprising pumps, valves and pipes for diverting said combined aqueous liquid fraction to the stripper unit.

4. The system according to any of claims 2 and 3, wherein the stripping of volatile compounds in the stripper unit results in the formation of a stripped aqueous liquid medium comprising at the most 200 ppm volatile compounds, such as at the most 100 ppm volatile compounds, for example at the most 50 ppm volatile compounds.

5. The system according to claim 4, wherein said second condensing device comprises two heat exchangers for cooling said hot volatile compound-comprising steam in two steps, said cooling generating said condensate comprising volatile compounds in two steps, said second condensing device further generating a heating source, said system further comprising pumps, valves and pipes for directing said heating source to said evaporator for heating aqueous liquid in said evaporator.

6. The system according to any of claims 1 to 5 further comprising means for diverting aqeuous liquid medium stripped for essentially all of said volatile compounds from said stripper unit to said shunt.

7. The system according to claim 1 wherein the shunt further comprises a pre-degassing unit for removing undesirable gasses affecting ammonia stripping, including undesirable gasses such as methane, carbondioxide and hydrogendisulphide, from the organic material before the remaining part of the organic material is contacted by the cold steam generated by the evaporator.

8. The system according to claim 1, wherein the aqueous liquid medium stripped for at least part of said volatile compounds is returned to the fermentor or biogas reactor from which the liquid medium was originally obtained.

9. The system according to claim 8, wherein the stripped aqueous liquid medium returned to the fermentor or biogas reactor is stripped for at least 10% of its content of volatile compounds.

10. The system according to claim 1, wherein said reference pressure is 1 bar.

11. The system according to claim 10, wherein the first pressure is from about 0.05 to about 0.4 bar.

12. The system according to claim 10, wherein the first pressure is from about 0.1 to 0.2 bar.

13. The system according to claim 10, wherein the second pressure is from about 2 to 3 bar.

14. The system according to claim 10, wherein said volatile compound is selected from the group of ammonia and amines, and other volatile organic and inorganic substances.

15. The system according to claim 14, wherein said volatile compound is ammonia.

16. The system according to claim 15, said system further comprising a phase separator for separating said condensate comprising volatile compounds from volatile compounds and vapour not condensed by the second condensing device.

17. The system according to any of claims 10 to 16, said system further comprising at least one air scrubber for cleaning said vapour not condensed by the first condensing device and/or said vapour not condensed by the second condensing device.

18. A mobile unit comprising the system according to any of claims 1 to 17, wherein said mobile unit can be connected to a fixed installation in the form of a fermentor or a biogas reactor.

19. A plant for processing organic material comprising solid and liquid parts, said plant comprising the system according to any of claims 1 to 17, said plant further comprising at least one fermentor and/or at least one biogas reactor, wherein said organic material is fermented at mesophilic and/or thermophilic conditions, wherein the stripper device for stripping volatile compounds is connected to the at least one fermentor and/or the at least one biogas reactor, wherein aqueous liquid medium from said at least one fermentor and/or said at least one biogas reactor can be diverted to the shunt through said connection.

20. The processing plant according to claim 19, said plant further comprising a stripper tank for stripping N (nitrogen), including ammonia, from the organic material prior to fermentation or biogas production.

21. The processing plant according to any of claims 19 and 20, said plant further comprising a pre-treatment tank for hydrolysing organic material prior to an initial N-stripping and/or fermentation and/or biogas production.

22. The processing plant according to any of claims 19 and 21, said plant further comprising a lime pressure cooker for hydrolysing organic material, wherein said hydrolysis results in eliminating, inactivating and/or reducing in number any viable microbial organisms and/or pathogenic substances present in the organic material.

23. The processing plant according to any of claims 19 and 22, said plant further comprising at least one silage store for generating ensiled plant material comprising at least one or more of corn/maize, energy crops, beets, and crop residues.

24. The processing plant according to claim 23, said plant further comprising a pre-treatment fermenting tank for fermenting silage and/or lime pressure cooked organic material, in which the fermentation conditions are selected from mesophilic fermentation conditions and thermophilic fermentation conditions.

25. The processing plant according to claim 19 comprising

i) a lime pressure cooker for hydrolysing the organic material,

ii) a stripper tank for stripping ammonia from said lime pressure cooked organic material, and

iii) a fermentor for fermenting said lime pressure cooked and ammonia stripped organic material.

26. The plant according to claim 25 further comprising a reception station for receiving organic material comprising solid parts and a transport and homogenisation system for homogenizing organic material comprising solid

parts and transporting the homogenized organic material comprising solid parts to the lime pressure cooker.

27. The plant according to claim 26, wherein the transport and homogenisation system for homogenizing and transporting the homogenized organic material comprising solid parts to the lime pressure cooker comprises screw conveyors and an integrated macerator.

28. The plant according to any of claims 26 and 27, wherein the reception station is fitted with screw conveyors in the floor of the reception section, and wherein the transport and homogenisation system can receive the organic material comprising solid parts from the screw conveyors located in the floor of the reception station.

29. The plant according to claim 26, wherein the lime pressure cooker is also connected to a reception tank for receiving liquid organic material such as organic slurries, wherein liquid organic material can be diverted from said reception tank to said lime pressure cooker.

30. The plant according to any of claims 25 to 29, wherein the lime pressure cooker comprises a single chamber and a stirrer, an entry port for entering organic material to be lime pressure cooked, and an outlet for diverting the lime pressure cooked organic material to a mixing tank or to a fermentor or biogas reactor connected to the system according to any of claims 1 to 17.

31. The plant according to claim 30, wherein a container for lime addition is connected to the lime pressure cooker, and wherein the mixing tank connected to the lime pressure cooker is also connected to the reception tank for receiving organic slurries, wherein the mixing tank is used for mixing lime pressure cooked organic material with organic slurries diverted to the mixing tank from the reception tank.

32. The plant according to claim 31, wherein the container for lime addition comprises a by-pass for adding lime directly into the mixing tank.

33. The plant according to any of claims 30 to 32, wherein the mixing tank is connected to the stripper tank so that the mixture of the lime pressure cooked organic material and the organic slurries from the reception tank can be pumped into the stripper tank.

34. The plant according to claim 33, wherein the stripper tank is further connected to the reception tank in order to receive organic slurries from the reception tank and also connected to the lime pressure cooker in order to receive lime pressure cooked organic material from the lime pressure cooker.

35. The plant according to any of claims 30 to 34, wherein the mixing tank and the stripper tank are connected by a macerator for macerating lime pressure cooked organic material and organic slurries to be diverted from the mixing tank to the stripper tank.

36. The plant according to any of claims 30 to 35, wherein the stripper tank is connected to an absorption system comprising a base adsorber for adsorbing acidic compounds, an acid adsorber for adsorbing basic compounds, and a hypochlorite oxidizer for oxidizing neutral compounds.

37. The plant according to claim 36, wherein the acid adsorber absorbs ammonia stripped from the stripper tank.

38. The plant according to claim 37, wherein the absorption unit is connected to a sulphoric acid tank and to a tank for storing the final ammonia condensate.

39. The plant according to claim 38, wherein the final ammonia condensate contains ammonia in a concentration of more than 10% (v/v), such as more than 15% (v/v), for example more than 20% (v/v).

40. The plant according to any of claims 36 to 39, wherein the lime pressure cooker is also connected to the absorption unit, and wherein any ammonia stripped from the lime pressure cooked organic material is also diverted to the absorption unit.

41. The plant according to any of claims 25 to 40, wherein the plant further comprises an animal housing system connected to a collection tank for collection of organic slurries produced by the animals in the animal housing system, wherein the collection tank is connected by a pump to the reception tank for receiving organic sluries so that organic slurries can be pumped from the collection tank to the reception tank.

42. The plant according to claim 41, wherein the collection tank is located below the floor of the animal housing system so that organic slurries can be diverted to the collection tank by means of gravitation.

43. The plant according to any of claims 25 to 42, wherein the plant further comprises a pre-treatment fermentation tank for fermenting lime pressure cooked organic material before the lime pressure cooked organic material is subjected to a second ammonia stripping step in the stripper tank for stripping ammonia from said lime pressure cooked and fermented organic material.

44. The plant according to any of claims 25 to 42, wherein the plant further comprises a pre-treatment fermentation tank for fermenting organic material before the organic material is subjected to lime pressure cooking and ammonia stripping.

45. The plant according to any of claims 43 and 44, wherein the stripper tank and/or the lime pressure cooker is connected to a silage store comprising a fermentable organic material.

46. The plant according to claim 45 further comprising an anerobic pre-treatment fermentation tank capable of removing gasses or odourants from silaged organic material and/or lime pressure cooked organic material, and wherein the silaged organic material and/or the lime pressure cooked organic material can be diverted to the anaerobic fermentation tank before being subsequently diverted to the stripper tank.

47. The plant according to claim 46, wherein the anaerobic pre-treatment fermentation tank is a thermophilic fermentation tank.

48. The plant according to claim 46, wherein the anaerobic pre-treatment fermentation tank is a mesophilic fermentation tank.

49. The plant according to any of claims 25 to 48, wherein the stripper tank is connected to at least one biogas producing fermentor connector to a system according to any of claims 1 to 17.

50. The plant according to claim 49, wherein the stripper tank is connected to a biogas producing multi-step fermentor system comprising three fermentors capable of operating at both thermophile conditions and mesophile conditions, wherein each fermentor is connected to a system according to any of claims 1 to 17.

51. The plant according to any of claims 49 and 50, wherein the biogas comprises mainly methane.

52. The plant according to any of claims 49 to 51, wherein the at least one biogas producing fermentor is connected to a tank for collection of biogas.

53. The plant according to any of claims 49 to 52 further comprising a gas cleaning unit for removing hydrogen sulphide and other odourants present in the produced biogas.

54. The plant according to any of claims 49 to 53 further comprising a gas fired engine connected to a generator for production of electric power and heat.

55. The plant according to claim 54, wherein the plant comprises pumps, valves and pipes allowing use of the energy generated by the gas fired engine for heating the stripper tank.

56. The plant according to claim 52, wherein the plant further comprises an outlet for diverting the biogas into a commercial biogas pipeline system.

57. The plant according to any of claims 49 and 50 further comprising a liquid biomass tank for diverting liquid biomass to the at least one biogas producing fermentor.

58. The plant according to any of claims 49 to 57 further comprising a decanter centrifuge for separating fermented organic material into a semi-solid fraction comprising 30-40% (w/w) dry matter of which 2 to 10% (w/w) is phosphor, and a liquid fraction comprising reject water.

59. The plant according to claim 58 further comprising a stripper device for stripping ammonia from the reject water, said stripper device comprising

a) an evaporator device comprising a sample of aqueous liquid to which heat obtained from an external heat source can be added, wherein a reduction of the pressure in said evaporator to a first pressure below 1 bar generates cold steam, and

b) pumps, valves and pipes for directing the cold steam generated by the evaporator of step a) through said reject water at a pressure below 1 bar, thereby stripping off ammonia from said reject water and obtaining a cold, ammonia comprising steam, and

c) a first condensing device operated at a pressure below 1 bar, and

d) pumps, valves and pipes for diverting said cold ammonia comprising steam at a pressure below 1 bar to the first condensing device for condensing in a first condensing step in said first condensing device said cold ammonia comprising steam at a pressure below 1 bar, thereby obtaining a first condensed aqueous liquid medium comprising ammonia and vapour not condensed by the first condensing device, and

e) a stripper unit for stripping ammonia at or above a pressure of 1 bar,

f) pumps, valves and pipes for diverting said first condensed aqueous liquid medium comprising ammonia obtained in step d) to the stripper unit, and

stripping off at least part of the ammonia by injecting hot steam at or above a pressure of 1 bar, thereby obtaining a hot ammonia comprising steam and aqueous liquid medium stripped off at least part of said ammonia,

g) a second condensing device, and

h) pumps, valves and pipes for diverting said hot ammonia comprising steam to a second condensing device, and condensing said hot volatile compound-comprising steam, thereby obtaining an ammonia condensate.

60. The plant according to any of claims 58 and 59 further comprising a reverse osmosis unit for separating potassium from the liquid fraction comprising reject water from which ammonia has been stripped, wherein the reverse osmosis unit comprises a) a pre-filter, and b) a reverse osmosis filter for filtering the permeate resulting from ceramic filtration, wherein the filtration preferably generates a liquid potassium concentrate of about 5-15% (v/v).

61. The plant according to claim 60, wherein the pre-filter separates particles larger than 0.1 μm (microns) from the reject water.

62. The plant according to claim 60, wherein the pre-filter separates particles larger than 0.01 μm (microns) from the reject water.

63. The plant according to claim 60, wherein the pre-filter separates particles larger than 0.001 μm (microns) from the reject water.

64. The plant according to 58, wherein a potassium concentrate is obtained from the reject water by using the energy generated by the gas fired engine of claim 54 for heating the reject water resulting from the decanter centrifugation step, wherein the heating results in a concentrate comprising potassium and a destillate for reuse.

65. The plant according to claim 60, wherein the permeate is used for flushing the manure cannals of the animal housing system.

66. The plant according to any of claims 25 to 65, wherein the organic material is selected from the group consisting of

manures and slurries thereof, such as manures and slurries obtained from cattle, pigs and poultry,

deep litter,

corn/maize, energy crops, beets, clover grass, and crop residues,

silaged crops,

slaugtherhouse waste, animal biproducts such as carcasses and fractions thereof,

meat and bone meal,

blood plasma,

risk and no-risk material with respect to the potential presence of BSE-prions or other prions.

67. The plant according to any of claims 25 to 65, wherein the organic material comprises organic material of animal origin having an amount of nitrogen (N) of from 1%(w/w) to preferably less than 20%(w/w).

68. A method for controlling the fermentation of organic material comprising undesirable volatile compounds, said method comprising the steps of

a) providing a fermentor comprising a liquid medium comprising organic material and a biomass capable of fermenting said organic material,
b) diverting said liquid medium to a side stream of the fermentor in the form of a shunt,
c) contacting said liquid medium in said shunt with cold steam at a first pressure below 1 bar, thereby obtaining a cold steam comprising volatile

compounds and liquid medium at least partly stripped for volatile compounds,

d) condensing said cold steam comprising volatile compounds, thereby obtaining a first condensed liquid medium,

e) injecting hot steam into said first condensed liquid medium at a second pressure of at least about 1 bar,

f) stripping off at least part of said volatile compounds comprised in said first condensed liquid medium, and obtaining a hot steam of volatile compounds and a condensed liquid medium stripped for essentially all volatile compounds, and

g) redirecting said liquid medium at least partly stripped for volatile compounds in step c) to said fermentor, and/or returning said condensed liquid medium stripped for essentially all volatile compounds in step f) to said shunt or to said fermentor, wherein said stripping of volatile compounds and said redirection of said at least partly stripped liquid medium controls the fermentation of said organic material.

69. A method for stripping volatile compounds from a liquid medium, said method comprising the steps of

a) providing an aqueous liquid medium comprising volatile compounds, and

b) diverting said liquid medium comprising volatile compounds to a shunt operably linked to a heating source such as an evaporator and a condensing device,

c) obtaining cold steam in the evaporator by adding heat to a sample of aqueous liquid and reducing the pressure below a predetermined reference pressure, and

d) directing said cold steam through said liquid medium comprising volatile compounds in the shunt of the stripper device at said pressure below a predetermined reference pressure, preferably 1 bar, thereby stripping off volatile compounds and obtaining a cold volatile compound-comprising steam, and

e) diverting said cold volatile compound-comprising steam at said pressure below a predetermined reference pressure to a first condensing device, and

f) condensing in a first condensing step said cold volatile compound-comprising steam at said pressure below a predetermined reference pressure, thereby obtaining a first condensed aqueous liquid medium comprising volatile compounds, and

g) diverting said first condensed aqueous liquid medium comprising volatile compound to a stripper unit, and

h) stripping off the volatile compound from said first condensed aqueous liquid medium comprising volatile compound by heating said first condensed aqueous liquid in said stripper unit at a higher second pressure, preferably a pressure of 1 bar or more, and obtaining a liquid with a reduced concentration of volatile compounds.

70. The method of any of claims 68 and 69, wherein the system according to any of claims 1 to 24 is used for operating the method.

71. The method of claim 69, wherein in step f) is further obtained a vapour not condensed by the first condensing device, and said vapour not condensed by the first condensing device is diverted to a further condensing device at said pressure below a predetermined reference pressure, removing part of the remaining volatile compounds from said vapour not condensed by the first condensing device by washing in a counter current of aqueous liquid, obtaining a aqueous liquid fraction comprising volatile compounds and vapour not condensed by the further condensing device.

72. The method of claim 69, wherein in step g) said aqueous liquid fraction of claim 71 comprising volatile compounds is further diverted to said stripper unit, and wherein in step h) volatile compounds are stripped from said first condensed aqueous liquid medium comprising volatile compounds and said aqueous liquid fraction comprising volatile compounds by heating at said second pressure, thereby obtaining a hot volatile compounds-comprising steam and aqueous liquid stripped off at least part of said volatile compounds.

73. The method of claim 72, wherein said hot volatile compound-comprising steam is diverted to a second condensing device, condensing said hot volatile compound-comprising steam at or above said reference pressure, thereby

obtaining a second condensed aqueous liquid medium comprising volatile compounds and vapour not condensed by the second condensing device.

74. The method of claim 69, wherein the aqueous liquid medium stripped for at least part of said volatile compounds is returned to the fermentor or biogas reactor from which the liquid medium was originally obtained.

75. The method of claim 74, wherein the aqueous liquid medium returned to the fermentor or biogas reactor is stripped for at least 20% such as at least 10% of its content of volatile compounds.

76. The method of any of claims 69 to 75, wherein said reference pressure is 1 bar.

77. The method of claim 76, wherein the first pressure is from about 0.1 to 0.4 bar.

78. The method of claim 76, wherein the second pressure is from about 1 to 4 bar, preferably from 1 to 3 bar, such as about 2.5 bar.

79. The method of any of claims 69 to 78, wherein said volatile compound is selected from the group of ammonia and volatile amines.

80. The method of claim 79, wherein said volatile compound is ammonia.

81. The method of claim 69 to 80, wherein said pressure below a predetermined reference pressure is obtained in the evaporator, the shunt, the first condensing device and the further condensing device.

82. The method of claim 69 to 81, wherein said pressure in the evaporator below a predetermined reference pressure is in the range of from 0.1 to 1.0 bar, for example from 0.1 to 0.4 bar, such as about 0.1 to 0.35 bar.

83. The method of claim 82, wherein said pressure below a predetermined reference pressure in the first condensing device and in the further condensing device is about 0.2 bar.

84. The method of claim 82, wherein the pressure in the stripper unit is about 2.5 bar.

85. The method of any of claims 69 to 84, wherein the cold steam is obtained by heating aqueous liquid in the evaporator to a temperature of 50 to 80°C, such as to a temperature of from 60°C to 75°C, such as to a temperature of about 70°C.

86. The method of any of claims 69 to 85, wherein the temperature of said first condensed aqueous liquid medium comprising volatile compounds and/or said vapour not condensed by the first condensing device is 15-35°C, such as 20-30°C, for example 23-28°C, such as about 25°C.

87. The method of any of claims 69 to 86, wherein the temperature of said counter current of aqueous liquid in the further condensing device is 15-35°C, such as 20-30°C, for example 23-28°C, such as about 25°C.

88. The method of any of claims 69 to 87, wherein the temperature of said first condensed aqueous liquid medium comprising volatile compounds and/or of said aqueous liquid fraction comprising volatile compounds in the stripper unit is from about 100°C to about 180°C.

89. The method of claim 88, wherein the temperature is from about 100°C to about 150°C.

90. The method of any of claims 69 to 89, wherein the temperature of said second condensed aqueous liquid and/or vapour not condensed by the second condensing device is 15-45°C, such as 20-40°C, for example 25-35°C, such as about 30°C.

91. The method of any of claims 69 to 90, wherein said aqueous liquid medium comprising volatile compounds comprises an amount of from 2.5 to 8 kg volatile compounds per m^3 (cubic meter) such as 2.6 to 5 kg volatile compounds per m^3 such as 2.7 to 3.5 kg volatile compounds per m^3.

92. The method of any of claims 68 to 91, wherein the liquid medium comprising volatile compounds is liquid medium comprising organic materials, preferably a liquid from a bioreactor, such as a bioreactor for treating organic waste, in particular a bioreactor for treating manure.

93. A method of any of claims 68 to 92, wherein the cold volatile compounds-comprising steam comprises volatile compounds in a concentration of about 0.5 to 10 % volatile compounds, preferable 0.5 to 8.0 % volatile compounds, such as about 0.5 to 7.0 % volatile compounds, for example about 0.5 to 6.0 % volatile compounds, such as about 0.5 to 5.0 % volatile compounds.

94. A method of any of claims 69 to 93, wherein said aqueous liquid medium comprising a reduced concentration of volatile compounds is re-directed to a bioreactor, such as to the bioreactor from where said liquid medium comprising volatile compounds was obtained, or to a bioreactor in connection to the bioreactor from where said liquid medium comprising volatile compounds was obtained.

95. A method of any of claims 69 to 94, wherein biomasses selected from the group of meat and bone meal, vegetable protein, molasses and vinasse are fermented, including any combination thereof.

96. A method of claim 95, wherein the amount of meat and bone meal fermented in the bioreactor comprises more than 2.5 %, such as more than 5 %, preferable more than 10 %, such as more than 15 %, such as more than 20 %, such as more than 25 % of the total biomass by weight.

97. A method of any of claims 68 to 96, wherein the bioreactor is a mesophilic or thermophilic bioreactor.

98. A method of any of claims 69 to 97, wherein the heating process in the evaporator is conducted by using heat exchangers reusing heat from engines or motor generators, or by adding to the evaporator warm waste aqueous liquids, or aqueous liquid obtained from a cooling/condensing device, such as the first condensing device and/or the second condensing device.

99. The method of any of claims 69 to 98, wherein the volatile compound is ammonia, and wherein said condensed aqueous, ammonia comprising liquid resulting from condensation in said second condensing device is of commercial fertiliser grade.

100. The method of any of claims 69 to 99, wherein said vapour not condensed by the second and/or second condensing device is directed to an air scrubber or directly to the atmosphere.